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Using homework to develop science capital

Matthew Livesey and Leigh Hoath

Abstract This article picks up on the notion of science capital (see Mytum-Smithson and Howell (2019) on p. 55 in this issue) and demonstrates how homework can be used to support its development. Science capital is an increasingly discussed term within some education camps and one that fashionably describes the 'science baggage' that children carry with them. It will be used to set the context for the main content of this article. The article is formed through two different perspectives on education. First there is the theoretical view from an academic stance (Leigh Hoath). This is then grounded in examples from classroom teaching (Matthew Livesey). The conclusion then explains how these fit together.

The academic view

The notion of capital stems from Bourdieu (1986) who describes it as something that takes time to accumulate and presents itself in one of three forms: economic, social or cultural capital. Within the finer detail of social capital is the notion of networking and connectedness with others. We learn a lot from those we spend time with – some good, some bad! – and every time we take something from one of those connections, experiences or achievements we build capital of one form or another. I am delighted that there is increasing recognition of the role that science capital plays in a learner's view and appreciation of science as a subject; and it is generally accepted that if a learner has more science capital then they are more likely to continue with science subjects through their education and potentially into a career. There are some elements of the topic that I am not comfortable with. The strong link that children who come from low socio-economic status backgrounds are more likely to have less science capital needs to be treated carefully. There is a danger that low science capital becomes synonymous with being poor. There are plenty of affluent families who have strong backgrounds in the arts and therefore their children are less likely to have high science capital and more likely to have high 'arts capital', if we can apply the same principles.

The Institute of Education at University College London (UCL) produced the 'science capital teaching approach' – an outcome from a significant amount of work and research over a number of years. There is evidence within this to suggest that adopting this teaching approach has benefits in terms of the learners' engagement and longer term valuing of science, and in my view anything that achieves this is a very welcome intervention in the world of education. There is an amount of this which, to me, feels like *good teaching*. I appreciate that it is a little more sophisticated than couching science in contexts that learners have an interest in and personalising it, but this is certainly part of it. I am a little frustrated too. The ASPIRES projects (based at King's College London from 2009 to 2017; the ASPIRES 2 project is now based at the UCL Institute of Education) have suggested that, if learners are turned off science, this happens by the age of 11. So, why has the research focused on the secondary age phase? There is some amazing science taking place across the UK in primary science and surely this is where we should be capturing the interests of learners in an attempt to ultimately address the STEM career issues that have been discussed within the education and wider public domains for a significant period of time. Primary teachers have a much greater contact time with their learners – let's support them in engaging the children at a younger age and then the secondary teachers will inherit classes of already turned on scientists. This is coupled, however, with the issue that science is not consistently taught across the primary curriculum from school to school and therefore there are pockets of excellence rather than it being a typical starting point.

One way of encouraging the development of science capital is through a raising of the profile of science in the home. Had I taken science homework home to my parents they would not have known where to start with it – I have no idea where my science capital gathering started and how it continued to the point where I am where I am now. Offering learners activities and homework that can involve their parents or carers in learning the science too is one approach to supporting the science agenda within education. The first step is making learners aware that science really is all around them and that almost everything they touch in the home exists because of some scientific process.

The school-based activity

It is (or arguably should be!) ingrained into every science teacher's lesson plans to try to contextualise the information and teaching content, making it as relevant as possible to the lives of the students. Such contextualisation helps with retention and recall of the content, as well as with building confidence in answering questions that demand the application of knowledge – which are now frequently encountered by students in the GCSE (16+) and A-level (18+) public examinations. Finding a way within lessons and during homework time to boost this application of knowledge and increase science capital during the younger phases of secondary education must go some way in helping them through their science education.

Not surprisingly, giving the students in my classes a worksheet or activity that assesses the taught content in the lessons does not tend to engage or promote the development of their science capital, although it does give a reasonable view of their progress. In an attempt to add more value to the homework task and make this more meaningful for the learners, I gave 24 students in year 8 (age 12–13) a homework task to work with their parents or carers to find examples of science within the home environment that related generally to the three science disciplines (biology, chemistry and physics) and, more specifically, to the topics that they were then studying. The idea behind the activity was to allow the students to explain the theory of their topic of study to their parents and together come up with daily examples – embedding the theoretical knowledge while attempting to increase science capital through recognition of real-life and 'at hand' contexts. At first, students were slightly perplexed at the instructions and questioned the validity of the exercise, some calling it a 'waste of time'. However, on submission, most agreed that this had been a worthwhile task that they had enjoyed completing, with some of them submitting outstanding responses and questions (Figures 1 and 2).

From the responses, it would appear, perhaps surprisingly, that students find it much easier to relate the knowledge they acquire in chemistry and physics to their home lives than biology – the variety and number of responses far outweighed those for biology. Since I was teaching the physical sciences at the time, it is possible that the students had deliberately omitted biological examples – another reason why it is important to teach science in an integrated way, as most contexts in our daily lives are not confined to just one of the science disciplines, potentially making it difficult for the learners to categorise their observations.

Some of the learners enjoy cooking with their friends and parents, which led to food being the main theme running through many of the observations, almost all making links to chemical and physical changes. Most students in the class observed that there was a chemical change occurring when they cooked a meal or when they baked a cake. One student went on to try to identify the reasons behind why onions make you cry when you cut them up, making some good links between particles, diffusion and the production of an acid from a chemical reaction occurring in the eye. The trickiest food-related observation was linked to making bread. Again, the idea of a chemical reaction occurring was noted, but no student made links to the use of a microorganism, yeast, producing carbon dioxide gas from respiration causing the dough to rise – despite this being their current topic of study in their biology lessons. One boy even posed an important scientific question – why does my cereal float

1. Biology:
What can you see and how does this work?
I can see my two cocker spaniels, sat lovingly staring at me! They are organisms, like humans. They work in literally the same way as humans – they are omnivores, they have personal preferences and they have all the same systems as us humans e.g. the digestive systems, the nervous system, the ~~tora~~ respiratory system e.c.t. I see a cactus in a mini plant pot. This is a plant. It gets sunlight from the sun out of my window and I water it. With a perfect temperature too, it is able to photosynthesise healthily.

2. Chemistry:
What can you see and how does this work?
I can see my lava lamp. It has gone through a physical change because the wax has melted and so moves free around the lamp. This change is not a physical change because it is reversible, but most importantly, no new substances have been produced. I see a chemical change when I bake bread in the oven. The particles bond together making a new substance. This is a irreversible change. I see combustion when we light the fire as the wood burns.

3. Physics.
What do you see and how does this work?
I see a light. This works in a way that an electrical current flows from the mains power around a circuit and into ~~it~~ the light, lighting the bulb. If the bulb goes and there are other bulbs in the circuit then the circuit will be incomplete so it will not light. I see magnetism when I look at the fridge magnet. Magnetism is a force. The closer the magnetic material is to the magnet, ~~the stro~~ (especially the poles), the stronger the attraction or in some cases, with other magnets, the stronger the repel.

Figure 1 Examples of the homework focused on 'what can you see and how does it work?'

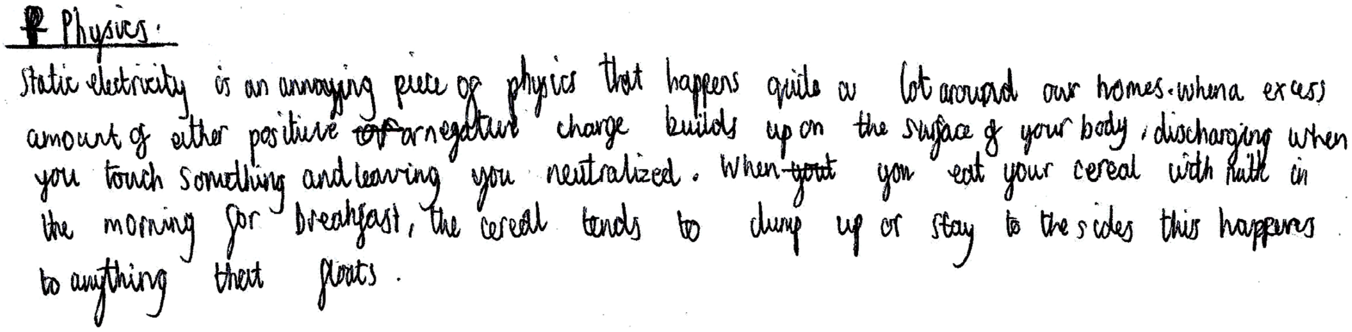
Physics.
Static electricity is an annoying piece of physics that happens quite a lot around our homes. when a excess amount of either positive ~~of~~ or negative charge builds up on the surface of your body, discharging when you touch something and leaving you neutralized. When ~~yout~~ you eat your cereal with milk in the morning for breakfast, the cereal tends to clump up or stay to the sides this happens to anything that floats.

Figure 2 A description of static electricity as experienced by the learner

in the milk? – bringing physics concepts to the breakfast table.

Another very common theme was the use of electricity and electrical devices in the home environment, ranging from how a light bulb works to charging up a mobile phone battery to store energy transferred electrically from the grid. All students in this class showed that physics occurs around them in one form as electricity. Other ideas suggested by the students that link to physics included fridge magnets and friction generated on their bike brakes.

Relating biology to the real world appeared to be the trickiest, only revealing one category of response from many students. They all commented on having plants in their homes and correctly described the need to keep them watered and in the correct conditions. It is interesting to note that many students didn't relate to themselves as organisms and as an example of biology in their daily lives, but some did refer to their pets being organisms. Perhaps if this exercise had been set within the context of biology lessons then the responses received may have been more life science orientated.

More in-depth questioning of the students would be required to ascertain whether they are able to give further examples of science in the home. However, as a way of engaging the students with the science content and increasing their science capital, this activity proved to be popular among the learners in helping them realise that science *is* all around them in their daily lives, and the content of science lessons *do* relate to the real world.

Conclusion

One of the greatest concerns emerging from the science capital research to date is the idea that learners see science as '*not being for me*' (Godec, King and Archer, 2017). It is imperative for us, as experienced teachers of science and those who have 'high science capital', to try to make explicit to learners what we see as the science that is all around us. The homework example described in this article is just one simple way to engage students and their carers with looking for science that surrounds them on a daily basis. It also goes beyond simply a list of written outcomes – the homework provided the opportunity to develop a dialogue between learners and parents/carers; it set a real context for the content taught in lessons and allowed the learners to *apply* it *to them*. It helped them to see where science is in their everyday lives and hopefully made steps in coaxing them towards science being *for them*.

We believe that a simple activity like this helps to promote the development of science capital, but we are not naïve about the demands of assessment. However, this activity and others like it also embed the theoretical knowledge learners require for examinations by giving them the opportunity to apply what they have learned in a different way to what they are used to in the classroom.

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